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PRELIMINARY HANDBOOK
OF
OPERATION AND SERVICE INSTRUCTIONS
FOR
SIGNAL GENERATOR BSG-7

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FOR

SIGNAL GENERATOR BSG-7

Babcock Radio Engineering, Inc.
7942 Woodley Avenue
Van Nuys, Calif.

SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION.

1-2. This publication is issued as the preliminary Handbook of Operation and Service Instructions for Signal Generator BSG-7, manufactured by Babcock Radio Engineering, Incorporated, Van Nuys, California.

1-3. This handbook contains descriptive data, basic operational theory, illustrations, operation instructions, and service information which is intended to facilitate understanding of the subject equipment.

1-4. PURPOSE OF EQUIPMENT.

1-5. The Signal Generator BSG-7 is primarily designed as a test generator for FM radio receivers operating in the range of 406 to 420 megacycles using carrier deviations up to ± 300 kilocycles. The BSG-7 is a portable instrument providing frequency modulated r-f carrier signals of accurately known frequency and amplitude. Although designed as a laboratory standard, the BSG-7 is sufficiently flexible for use in production testing or field maintenance of FM equipment operating in the aforementioned range of frequency and deviation.

1-6. GENERAL CHARACTERISTICS.

1-7. CARRIER FREQUENCY RANGE. An output carrier can be obtained at any frequency between the limits of 406 to 420 megacycles, in one megacycle increments. The carrier frequencies are crystal controlled and are accurate to 0.01 percent. Selection of the carrier frequency is determined by the setting of a 15 position FREQUENCY knob located on the front panel.

1-8. CARRIER OUTPUT SYSTEM. The output carrier can be continuously varied in amplitude from one to 100,000 microvolts. Selection of carrier output level is determined by setting of a calibrated carrier output knob, and by means of an RF OUTPUT meter and OUTPUT TUNING knob located on the front panel.

1-9. OUTPUT IMPEDANCE. The signal generator output impedance is 52 ohms. This impedance appears across an RF OUTPUT receptacle located on the front panel. Stray radiation or r-f leakage is less than 5 microvolts at any point outside the case.

1-10 EXTERNAL MODULATION. The r-f carrier output is capable of being frequency modulated at any frequency between 1 and 80 kilocycles by external means. External modulation is introduced through an EXT. AUDIO receptacle located on the front panel. An external modulation voltage having an amplitude between 1 and 2 volts RMS applied to the EXT. AUDIO receptacle is sufficient to frequency modulate the carrier ± 300 kilocycles. The input impedance of the EXT. AUDIO receptacle is 560 ohms. Deviation is controlled by a DEVIATION knob and is indicated by a DEVIATION meter. The DEVIATION meter is calibrated in ± 50 kilocycle increments and is provided with a red index marker to indicate ± 300 kilocycles. The selection of external modulation is accomplished when the MODULATION switch is positioned to EXT.

1-11. INTERNAL MODULATION. The r-f carrier output is capable of being internally frequency modulated at any one of six fixed frequencies. Internal modulation is accomplished when the MODULATION switch is positioned to INT. and the corresponding MODULATION FREQUENCY switch is operated. As in the case of external modulation, deviation is controlled by the DEVIATION knob and is monitored by the DEVIATION meter. Each of the internal modulation oscillators develops sufficient output to frequency modulate the r-f carrier in excess of ± 300 kilocycles. Accuracy of the six frequency modulation oscillators is plus or minus one percent.

1-12. POWER REQUIREMENTS. The subject generator operates with an input potential of 115 volts ± 10 percent AC at 50-1000 cycles and consumes approximately 200 watts of power. Primary power circuits are protected by a three ampere fuse which is accessible from the front panel.

1-13. POWER CIRCUITS. Primary input power is controlled by a POWER switch and is monitored by a POWER lamp located on the front panel. B+ power developed by an internal power supply is controlled by a CARRIER switch and is monitored by a CARRIER lamp located on the front panel. A CODER POWER receptacle located on the front panel provides a means of connecting the internal B+ and tube heater power sources of the signal generator to an associated coder such as the KY-51/ARW, KY-133/ARW-66 and similar equipments.

1-14. MONITORING. An AF MONITOR receptacle located on the front panel provides a means of monitoring either external or internal modulation signals.

1-15. PHYSICAL DESCRIPTION.

1-16. Component parts of the BSG-7 are housed within a rectangular metal case. The majority of components are mounted on a chassis assembly which is enclosed by the outer case. The outer case is provided with shockmounts and carrying handles. The chassis assembly is provided with a front panel which extends outside the case and mounts all of the operating controls and indicating devices. Access to chassis assembly components is obtained when the chassis is removed from the case housing. This can be accomplished by loosening the fourteen captive screws and sliding the case from the chassis. Chassis assembly components consist essentially of two r-f strips, six a-f oscillator circuits, a metering circuit and power supply components. All adjustment controls for the a-f oscillators, deviation metering and frequency deviation circuits are accessible from the chassis underside. All adjustment controls for the r-f and r-f output metering sections are accessible from the chassis topside.

SECTION II

THEORY OF OPERATION

2-1. GENERAL.

2-2. The BSG-7 Signal Generator consists essentially of two r-f sections, a deviation control section, a deviation metering section, an a-f modulation section and a power supply section. Basic operational principles of these sections are as follows.

2-3. OUTPUT RF SECTION. Electron tube V-301 functions as a crystal oscillator and produces an output frequency dependent upon the selection of crystals. Any

one of 15 crystals can be selected by the FREQUENCY knob. The output from V-301 is applied to V-302 where it is multiplied by a factor of 4. The output from V-302 is combined with an output from the modulation r-f section in mixer stage V-303. Electron tube V-304 amplifies the difference frequency signal from V-303 and delivers its output to V-305 where the frequency is tripled. Final amplifier stage V-306 is driven by V-305 and delivers its output through the attenuation control AT-301. The 406 to 420 megacycle output from AT-301 is applied to the RF OUTPUT receptacle J-103 through a 52 ohm impedance network and to the RF OUTPUT meter through a crystal rectifier and meter adjustment circuit.

2-4. MODULATION RF SECTION. Electron tube V-201 functions as a crystal oscillator and delivers a signal to V-203. Electron tube V-202 is placed across the tank circuit and functions as a reactance modulator to phase modulate the signal from V-201. Modulation signals from the deviation control section are impressed on the cathode of V-202. The output from V-201 is successively multiplied by each of the stages containing electron tubes V-203, V-204, V-205, V-206, V-207 and V-208. The 150 megacycle output from V-208 is applied through J-202 and an internal coaxial cable to mixer stage V-303 in the output r-f section.

2-5. DEVIATION CONTROL SECTION. Either internal or external modulation signals are applied across DEVIATION potentiometer R-110. The output from R-110 is applied to the input grid of V-102 through internal deviation control R-164. The output from V-102 is applied to V-101 where it is amplified and applied to the cathode of reactance modulator V-202 in the modulation r-f section.

2-6. DEVIATION METERING SECTION. The internal or external modulation signals applied to the deviation control section are also applied to V-109 through internal deviation metering control R-145. The output from V-109 is applied to V-110 where it is amplified and delivered to the DEVIATION meter through a rectifier and resistor bridge circuit.

2-7. AF MODULATION SECTION. Electron tubes V-103, V-104 and V-105, and their associated circuit components are connected to form six a-f oscillators. Individual oscillators are placed in operation when the corresponding MODULATION FREQUENCY switch is closed and a cathode-ground circuit is completed. Outputs from individual oscillators are controlled in amplitude by potentiometers R-115, R-120, R-125, R-130, R-135 and R-150. These outputs are applied to the first half of V-106 and are amplified. The second half of V-106 functions as a cathode follower and delivers its output to the DEVIATION potentiometer R-110 when the MODULATION switch is positioned to INT.

2-8. POWER SUPPLY SECTION. Primary 115 volts ac power is applied through receptacle J-105 and fuse F-101 to the POWER switch. When the POWER switch is OFF, power is applied to internal heaters which serve to maintain components at a stable operating temperature. When the POWER switch is ON, power is applied to the primary of transformer T-101 which is provided with four secondary windings. One secondary winding supplies 28 volts ac to pin G of CODER POWER receptacle J-101. Another secondary winding supplies 6.3 volts ac power to generator electron tube heaters. A third winding supplies 5 volts ac to rectifier V-111. The high potential ac secondary is center-tapped and supplies the plates of V-111. When the CARRIER switch is ON, the center-tap ground return is completed and V-111 functions to rectify the high potential ac. The rectified B+ potential that appears on the heater of V-111 is filtered and then distributed to various generator electron tubes and to pin A of CODER POWER receptacle J-101. V-107 and V-108 together with their associated dropping resistors provide sources of regulated dc for the crystal oscillators, modulator and internal audio oscillators that would otherwise be affected by line voltage changes.

SECTION III

OPERATION

3-1. GENERAL.

3-2. The subsequent paragraphs describe all operational procedures for the Signal Generator BSG-7. Due to design characteristics, operation of the subject unit is not complex. However, the using personnel should carefully study the following instructions to insure optimum performance and to minimize the possibility of erroneous readings due to misuse. Although these instructions are applicable to all conditions of operation and are in the normal sequence of operation, the using personnel need employ only those procedures which are required for their particular tests.

3-3. SETTING UP EQUIPMENT FOR OPERATION.

3-4. Proceed as follows to set up the unit for use.

a. Remove the unit and accessories from the transit case.
b. Place the generator on a suitable work bench or at the desired installation location.
c. If the accessory antenna is to be employed, mount the antenna on top of the case by means of the two captive screws and connect it to the RF OUTPUT receptacle on the generator front panel. The accessory r-f cable and cable adapter can be employed as necessary to make this attachment.

3-5. STARTING EQUIPMENT.

3-6. Proceed as follows to start the unit.

a. Connect the power cable to generator receptacle J-105 and to a source of 115 volts ac, 50 to 1000 cycle power. The generator receptacle J-105 is accessible from the back of the generator case and is located at the lower corner.

NOTE

Once the power cable is connected, the internal standby heaters of the generator will become energized and will remain energized until the POWER switch is positioned to ON. This will maintain internal components at a stable operating temperature during periods of non-use. It is recommended that the power cable be left connected if intermittent operation of the generator is anticipated.

b. Position the POWER switch to ON and note that the POWER lamp illuminates. This indicates that all electron tube heaters have been energized and that 24 volts ac power is available at pin 7 of CONT. ADJ. receptacle J-101. It is recommended that the electron tube heaters be allowed to warm up for a period of three minutes.

c. After a suitable warm-up period, position the CARRIER switch to ON and note that the CARRIER lamp illuminates. This indicates that the B+ power is available to all electron tubes and that +150 volts dc is available at pin A of CODER POWER receptacle J-101. The generator is now ready for operation.

3-7. OPERATION TO OBTAIN UNMODULATED RF CARRIER OUTPUT.

3-8. Proceed as follows to obtain an unmodulated r-f carrier output.

a. Rotate the FREQUENCY knob until the desired r-f carrier frequency inscribed on the knob rim is directly below the index pointer.
b. Rotate the inner carrier output dial clockwise until an indication is obtained on the RF output meter.
c. Rotate the OUTPUT TUNING knob as necessary to obtain a peak indication on the RF OUTPUT meter.
d. Rotate the inner carrier output dial until the RF OUTPUT meter needle is aligned with the red index mark.
e. Adjust the ring fiducial of the carrier output dial until its index mark is aligned with the inner carrier output dial 100K (100,000 microvolts) mark. The output level of the generator can now be adjusted by means of the inner carrier output dial. Rotate the inner dial until the desired output level (in microvolts) inscribed on the inner dial rim is exactly aligned with the ring fiducial index mark.

NOTE

The r-f level indication will be as indicated on the inner dial only when the load connected to J-103 is 52 ohms resistive at the output frequency.

f. An unmodulated r-f carrier output should now be available at the RF OUTPUT receptacle J-103. To frequency modulate this carrier at any one of the six internal modulation frequencies, follow the instructions of paragraph 3-9. To modulate the carrier at other frequencies obtained from an external source, follow the instructions of paragraph 3-11.

3-9. OPERATION TO OBTAIN INTERNAL FREQUENCY MODULATION.

3-10. Proceed as follows to obtain internal modulation at any one of the six preset a-f frequencies.

a. Make certain that all procedures of paragraphs 3-7 and 3-7 have been accomplished.
b. Position the MODULATION switch to INT.
c. Position the appropriate MODULATION FREQUENCY-CPS switch to select the desired modulation frequency.
d. Rotate the DEVIATION knob clockwise until the desired amount of frequency deviation is obtained as indicated by the DEVIATION meter. The deviation meter is calibrated in ± 50 Kilocycle increments. Ordinarily, the normal amount of deviation is ± 300 kilocycles. This point is indicated on the DEVIATION meter by a red index mark.

c. An r-f carrier output modulated at the selected frequency should now be available at the RF OUTPUT receptacle J-103. Any one of the additional five internal modulation frequencies can be selected by positioning the corresponding MODULATION FREQUENCY-CPS switch to ON. Several of the internal modulation frequencies or audio channels can be used simultaneously. In the case of multiple channel operation, the deviation level is adjusted to ± 300 kilocycles in the same manner as that for a single modulation frequency.

3-11. OPERATION TO OBTAIN EXTERNAL FREQUENCY MODULATION.

3-12. Proceed as follows to obtain external modulation of the r-f carrier.

a. Make certain that all procedures of paragraphs 3-5 and 3-7 have been accomplished.

b. Position the MODULATION switch to EXT.
c. Connect the output of the external modulation source to the EXT. AUDIO receptacle J-102. Monitoring of the external source may be accomplished by connecting the monitor device to J-104.
d. Adjust output of the external modulation source to the desired frequency. External modulation can be accomplished at any frequency between the limits of one to 50 kilocycles.
e. Adjust output of the external modulation source to a value between one and two volts ac.
f. Rotate the DEVIATION knob clockwise until the desired amount of frequency deviation is obtained as indicated by the DEVIATION meter. Under normal conditions, adjust the DEVIATION knob until the DEVIATION meter needle is aligned with the red (± 300 kilocycle) index mark.
g. An r-f carrier output modulated by the external source should now be available at the RF OUTPUT receptacle J-103.

NOTE

The A.F. MONITOR receptacle J-104 can be used as desired with either internal or external modulation. Also, the CODER POWER receptacle J-101 provides a means of using a coder such as the KY-133(XN-1)/ARW-66 with the signal generator. To use such a coder, connect a cable between the CODER POWER receptacle J-101 and the corresponding receptacle on the coder, connect a second cable between the EXT. AUDIO receptacle J-102 and the audio output receptacle of the coder, and follow the procedures of paragraphs 3-5, 3-7 and 3-11.

3-13. STOPPING THE EQUIPMENT.

3-14. Proceed as follows to stop the equipment.

a. Position the CARRIER switch to OFF and note that the CARRIER lamp is extinguished.
b. Position the POWER switch to OFF and note that the POWER lamp is extinguished. If standby operation is desired, leave the POWER switch ON and the CARRIER switch OFF.
c. If the equipment is to be secured for an extended period of time, remove the power cable from generator receptacle J-105. If intermittent operation is anticipated, leave the power cable in place. With this configuration, the internal heaters will remain energized.

In tropical climates the internal heaters should be energized when the equipment is secured for extended periods of time, or the signal generator should be replaced in the transit case and the transit case cover secured.

SECTION IV

MAINTENANCE AND ADJUSTMENTS

4-1. GENERAL.

4-2. The subsequent paragraphs describe all preliminary maintenance and adjustment procedures for the Signal Generator SG-7. Such procedures include fuse and electron tube replacement, adjustment of internal modulation oscillator frequencies, adjustment of internal modulation oscillator output levels, adjustment of deviation meter circuit input level and adjustment of frequency deviation level.

NOTE

The using personnel should not attempt any maintenance or adjustments beyond those specified in this section without reference to the appropriate maintenance or service handbook. Failure to observe this precaution will result in misalignment or other defects which will render the unit inoperative or will seriously affect performance. If appropriate handbooks are not available and the procedures outlined in this section do not correct troubles, contact the manufacturers representatives.

4-3. REPLACEMENT OF FUSES AND ELECTRON TUBES.

4-4. The subject unit contains only one fuse F-101 which is located on the front panel. A spare fuse is provided in the SPARE holder located directly above F-101. Fuse F-101 can be replaced if it proves to be defective by examination or by equipment failure. However, F-101 should not be replaced a second time without correcting the cause of trouble if it burns out immediately after replacement. Also, do not replace F-101 with a fuse of higher rating.

4-5. Any of the 25 electron tubes can be replaced by the using personnel. An attempt should be made to localize trouble before replacing tubes. If a tube is obviously defective, such as one with a broken envelope or burned out heater, it can be replaced without further examination. Other tubes can be checked by substitution or on a suitable tube tester, whichever method proves expedient. Paragraph 4-6 provides a general method of localizing troubles to individual or groups of tubes.

4-6. If the r-f carrier is absent, as indicated by the RF OUTPUT meter or by lack of r-f at the RF OUTPUT receptacle J-103, check for presence of 150 megacycle r-f at J-202. If r-f is present at J-202 but not at J-103 or on the RF OUTPUT meter, the trouble can be localized to electron tubes V-301 through V-306. If no r-f is present at J-202, check electron tubes V-201 through V-208. If an r-f carrier is present but no internal modulation of the carrier is obtained, check for a-f signals at the A.F. MONITOR receptacle J-104. If a-f signals are present at J-104 but the carrier is not modulated, the trouble can be localized to electron

tubes V-101 and V-102. If the r-f carrier is modulated but there is no indication on the DEVIATION meter, check V-109 and V-110. If there are no a-f signals at J-104, check electron tube V-106. If only one or two a-f modulation signals are absent, check the corresponding electron tubes V-103, V-104 or V-105. If the power supply is suspected of being defective, check V-111. Failure of V-111 will usually be evidenced by a lack of ionization in V-107 and V-108.

4-7. ADJUSTMENT OF INTERNAL MODULATION OSCILLATOR FREQUENCIES.

4-8. Proceed as follows to adjust internal modulation oscillator frequencies.

a. Loosen the 14 case attaching screws and remove the signal generator case. Place the generator on its side so that the internal modulation oscillator adjustment capacitors are accessible. Start the equipment as outlined in paragraph 3-5.

b. Position the Modulation switch to INT. Connect an accurate EPUT meter such as the Berkeley Model 554 to the A.F. MONITOR receptacle J-104.

c. Position the #1 MODULATION FREQUENCY switch to ON. Observe the frequency as indicated on the EPUT meter. If it is not within ± 1 percent of the proper frequency, adjust trimmer capacitor C-123 until an indication within ± 1 percent is obtained.

NOTE

The guaranteed accuracy of the audio oscillators under all operating conditions is ± 1 percent. However, they may be adjusted within a very few cycles by means of the trimmer capacitors. If accuracy better than ± 1 percent is required over long periods of time, the audio oscillators should be continuously monitored during use.

d. In turn, position the #2, #3, #4, #5 and #6 MODULATION FREQUENCY switches to ON. Observe the frequencies as indicated on the frequency meter. If any one or more of the frequencies are not correct, adjust the corresponding modulation oscillator trimmer capacitors until correct frequencies are obtained. The modulation oscillator frequencies are controlled by the following tuning capacitors: #1 by C-123, #2 by C-120, #3 by C-117, #4 by C-114, #5 by C-111, #6 by C-108. This completes adjustment of modulation oscillator frequencies.

4-9. ADJUSTMENT OF INTERNAL MODULATION OSCILLATOR OUTPUT LEVELS.

4-10. Proceed as follows to adjust internal modulation oscillator output levels.

a. Loosen the 14 case attaching screws and remove the signal generator case. Place the generator on its side so that the internal modulation oscillator output level potentiometers are accessible. Start the equipment as outlined in paragraph 3.5.

b. Position the MODULATION switch to INT. Connect an accurate VTVM such as the Hewlett Packard 400C to the A.F. MONITOR receptacle J-104.

c. Position the #1 MODULATION FREQUENCY switch to ON. Observe the a-f voltage level as indicated on the VTVM. If it is not 1.5 volts ac adjust R-140 until an indication of exactly 1.5 volts ac is obtained.

d. In turn, position the #2, #3, #4, #5 and #6 CPS MODULATION FREQUENCY switches to ON. Observe the output voltage levels as indicated on the VTVM. If any one or more of the output voltage levels are not 1.5 volts ac, adjust the corresponding modulation oscillator output level potentiometers until the indication is 1.5 volts ac. The modulation oscillator output levels are controlled by the following potentiometers. #1 cps by R-140, #2 cps by R-135, #3 cps. by R-130, #4 cps by R-125, #5 cps by R-120, #6 cps by R-115. This completes adjustment of modulation oscillator output levels.

4-11. ADJUSTMENT OF DEVIATION METER CIRCUIT INPUT LEVEL.

4-12. Proceed as follows to adjust deviation meter circuit input level.

a. Loosen the 4 case attaching screws and remove the signal generator case. Place the generator on its side so that the deviation meter circuit potentiometer R-145 and test point TP-101 are accessible. Test Point TP-101 is at the junction of DEVIATION potentiometer R-110 wiper arm, capacitor C-137 and capacitor C-131. Start the equipment as outlined in paragraph 3.5.

b. Position the Modulation switch to INT. Connect an accurate VTVM such as the Hewlett Packard 400C to test point TP-101. Place the #1 MODULATION FREQUENCY switch to ON. Adjust the DEVIATION knob until an indication of exactly 1.5 volts ac is obtained on the VTVM. Exercise care when setting this voltage since the accuracy of the deviation meter circuit is dependent upon the accuracy of the next adjustment.

c. Observe the DEVIATION meter. The needle should be at the red index mark to indicate ± 300 kilocycles deviation (with 1.5 volts ac at the deviation meter input circuit). If the needle is not at the ± 300 kilocycle deviation mark, adjust the meter input level potentiometer R-145 until the needle is aligned with the red index mark. Recheck to insure that the input voltage at test point TP-101 is exactly 1.5 volts ac. This completes adjustment of the deviation meter circuit input level potentiometer R-145.

4-13. ADJUSTMENT OF FREQUENCY DEVIATION LEVEL.

4-14. Proceed as follows to adjust the frequency deviation level.

a. Loosen the 4 case attaching screws and remove the signal generator case. Place the generator on its side so that the frequency deviation level potentiometer R-104 is accessible. Start the equipment as outlined in paragraphs 3-5 and 3-7.

b. Connect the RF OUTPUT receptacle J-103 to a suitable receiver such as the AN/URM-28. Tune the receiver to the r-f carrier output frequency of the generator as selected by the FREQUENCY knob. Connect a suitable panoramic adapter to the receiver output. Adjust controls on the receiver and panoramic adapter until a single unmodulated signal is observed at the center of the panoramic adapter screen.

c. Rotate the DEVIATION knob full counterclockwise. Position the MODULATION FREQUENCY switch to ON. Position the MODULATION switch to INT. Slowly rotate the DEVIATION knob clockwise and observe the r-f carrier signal on the panoramic adapter screen. Count the number of carrier disappearances as the DEVIATION knob is rotated clockwise. With 7500 cps modulation, the carrier will disappear 13 times for ± 300 kilocycles deviation. The DEVIATION meter needle should be at the red index mark indicating ± 300 kilocycle deviation.

d. If necessary, adjust the frequency deviation level potentiometer R-164 as required and recheck deviation as outlined in step c of this paragraph. Continue adjusting R-164 and checking deviation until exactly 13 carrier disappearances are obtained when the DEVIATION meter needle moves from zero to the red (± 300 kilocycle) index mark. This completes adjustment of frequency deviation level.